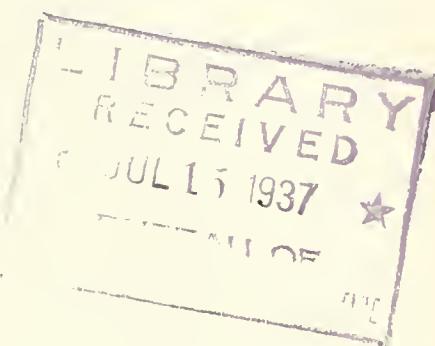


Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

THE INSECT PEST SURVEY
BULLETIN



Volume 17

Supplement to Number 3

May 15, 1937

BUREAU OF
ENTOMOLOGY AND PLANT QUARANTINE
UNITED STATES
DEPARTMENT OF AGRICULTURE
AND
THE STATE ENTOMOLOGICAL
AGENCIES COOPERATING

INSECT PEST SURVEY BULLETIN

Vol. 17

Supplement to No. 3

May 15, 1937

THE SPECIES AND DISTRIBUTION OF GRASSHOPPERS IN THE 1936 OUTBREAK

Robert L. Shotwell 1/

In the years 1934, 1935, and 1936 collections of grasshoppers in typical environments were made during the annual grasshopper survey in the several States included. The specimens collected were identified and counted to determine the percentage of each species in the total number taken in each habitat. Data from the 1934 and 1935 collections were published in the Insect Pest Survey Bulletin as supplement 9, volume 14, and as supplement 5, volume 16, respectively. The present report includes the data for the 1936 survey. This grasshopper survey covered 22 States but collections were recorded for only 9 of these. No collections were sent in from Iowa and Nebraska, States included in the 1935 report. Four additional States, viz., Illinois, Missouri, Arkansas, and Oklahoma, were included in the annual survey but in these States not enough collections were made for tabulation purposes. Data on important species in the States where no collections are recorded have been derived from reports by the surveyors. The material for the other States is tabulated and summarized according to principal crops or habitats.

So far as possible, collecting was limited to a certain crop or environment except where the collectors failed to observe these limitations. Because of the limited time available and the pressure of other matters, the collecting is incomplete and not all species present were obtained for any State; however, the results show the general shifts in relative abundance and importance of the more common species.

Collections are here recorded for Colorado, Michigan, Minnesota, Montana, North Dakota, South Dakota, Utah, Wisconsin, and Wyoming.

Weather Conditions during the Summer 1936

Throughout the entire area in which collections were made the summer of 1936 was the hottest and driest on record. In many localities daily maximum temperatures of over 100° F. were recorded during a total of 67 days in June,

1/ The writer is indebted to F. D. Butcher, of the Bureau of Entomology and Plant Quarantine, for his part in the identification of the specimens and organization of the material; also to Louis A. Spain, student assistant, who for the past 3 years has had a major part in the systematic work connected with this project.

July, and August. No moisture fell in some areas for 100 consecutive days. In Iowa, Nebraska, and Kansas most of the adult grasshoppers spent the greater part of their time in July and August roosting in the trees and shrubs, where they remained in a more or less inactive state. Collections made on the ground, therefore, could not be representative. Great mortality occurred among the adults from the heat and drought and this phenomenon will probably be reflected in the surveys made in 1937.

Natural Vegetation Areas in which Collections Were Made

The natural vegetation areas included in the grasshopper surveys have been described in detail in the report for 1935, issued as supplement 5, volume 16, of the Insect Pest Survey Bulletin. There are nine general areas, as follows: The northeastern pine forest; the northeastern and southern hardwood areas of Wisconsin and Michigan; the tall-grass prairies, embracing parts of Minnesota, Iowa, the Dakotas, Nebraska, and Kansas; the short-grass, or plains grasslands, of the Dakotas, Nebraska, Kansas, Colorado, Wyoming, and Montana; the foothills of South Dakota and of the mountain States; the montane and alpine meadows of the mountain States; and the northern desert-shrub or sagebrush areas of Wyoming, Utah, and Idaho.

In all of these natural vegetation areas man has disturbed the balance of nature in the original flora by his farming and grazing practices and by introducing new plants. This has had its effect on the grasshopper fauna. Changes in the relative abundance of species are rapid. In one year a certain species may be very numerous and even dominant, and in the next year or two it may practically disappear. The build-up of some of these species is due in part to the introduced food plants, largely crops, which, in turn, are more susceptible to weather changes than are the native plants that have become adapted to the environment. Therefore, the many and varied farming and grazing practices have increased instability among the species of grasshoppers and this, in part, accounts for recent outbreaks.

Infestations

The surveys showed the worst infestations to be located in western and southern Iowa, eastern Nebraska, southeastern Colorado, and northern Wyoming, with severe infestations in many other localities. Owing to the extreme heat and drought of the summer of 1936, it is difficult to predict abundance in 1937 in many of these places. For example, in South Dakota there were 26 counties that averaged from 5- to 100-percent infestation in the adult survey, whereas in the egg survey no eggs were found in these counties.

COLORADO

There are five natural vegetation areas in Colorado, viz., the plains, the foothills, low-mountain, high-mountain, and alpine. In 1935 the collections were made in each of these vegetation areas but in 1936 all were made in the farming areas of the plains grasslands. Altogether, 1,735 specimens, representing 39 species, were taken in the following environments: 31 species in corn, 30 species in small grains, 32 species in pastures, 11 species in row crops, and 39 species from roadsides.

Most of the infestation was limited to the eastern half of the State, as most of the western part is mountainous. From severe to very severe infestations were found along the foothill area and in the northeastern, east-central, and extreme southeastern parts. The general population was higher than in 1935.

No collections are recorded for the range areas but heavy infestations of Dissosteira longipennis Thos. occurred in the southeastern quarter of the State. From the standpoint of damage to crops, Melanoplus bivittatus Say, M. mexicanus Sauss., M. femur-rubrum Deg., and M. differentialis Thos. were the most destructive of all the species. Aeoloplus turnbullii Thos. and M. packardii Scudd. were also important species.

Detailed comparisons between collections of 1935 and 1936 cannot be made because that of 1935 was much more extensive than that of 1936. The distribution by species of 1,735 specimens collected in Colorado, expressed in percentages of total number taken in each habitat, is shown in the following table.

Species	Corn	Small grain	Leg- umes	Percentage collected in --				Total speci- mens	% of grand total
				Range plains	grass	Pasture	Row side		
<i>Aeoloplus turnbullii</i> Thos.	12.54	9.18	4.40	--	.92	1.09	7.89	136	7.84
<i>Ageneotettix deorum</i> Scudd.	1.46	1.13	2.80	--	.13	1.45	1.45	25	1.44
<i>Amphitornus coloradus</i> Thos.	--	.16	.42	--	.79	.12	.12	2	.11
<i>Arphia pseudonietana</i> Thos.	--	3.33	.10	.20	.04	.41	.41	7	.40
<i>Aulocara elliotti</i> Thos.	--	3.74	.10	1.00	.04	.60	.62	28	1.61
<i>Cannula pellucida</i> Scudd.	--	--	.50	--	.44	2.44	1.62	34	1.95
<i>Chortippus curtipennis</i> Harr.	--	--	.23	--	.49	--	.97	6	.34
<i>Derotmema haydeni</i> Thos.	--	--	.49	--	.13	.15	.34	14	.80
<i>Dissosteira carolina</i> L.	--	--	.20	--	.13	--	.06	35	2.02
<i>Dissosteira longipennis</i> Thos.	--	--	.15	--	.19	--	.06	1	.06
<i>Drepanopterna femoratum</i> Scudd.	--	1.46	.10	.20	.85	--	.58	10	.57
<i>Encyrtolophus costalis</i> Scudd.	--	2.27	--	--	.53	--	.81	14	.80
<i>Hadrotettix trifasciatus</i> Say	--	--	.98	.72	--	--	.06	9	.52
<i>Hesperotettix brevipennis</i> Thos.	--	--	.15	.10	.13	--	.12	2	.11
<i>Hippiscus rugosus</i> Scudd.	--	--	.33	.20	.13	--	.06	1	.06
<i>Hypochlora alba</i> Dodge	--	.16	--	--	.13	--	.06	2	.10
<i>Melanoplus angustipennis</i> Dodge	--	7.98	7.52	--	.43	4.41	.41	76	3.37
<i>Melanoplus bivittatus</i> Say	--	7.00	11.84	9.50	.10	24.36	10.67	184	10.60
<i>Melanoplus bowditchi</i> Scudd.	--	--	.41	--	.40	--	.23	1	.23
<i>Melanoplus dawsoni</i> Scudd.	--	.16	4.32	--	.13	--	.05	1	.05
<i>Melanoplus differentialis</i> Thos.	--	7.01	--	.60	.36	.60	.89	67	.86
<i>Melanoplus femur-rubrum</i> Deg.	--	3.75	4.43	45.80	.44	37.76	16.41	310	17.87
<i>Melanoplus flavidus</i> Scudd.	--	1.14	.72	--	--	--	.41	7	.40
<i>Melanoplus gladstoni</i> Scudd.	--	--	.82	.10	.30	--	.29	5	.29
<i>Melanoplus infantilis</i> Scudd.	--	--	.16	.10	.13	--	.12	2	.11
<i>Melanoplus keeleri</i> Thos.	--	--	.32	--	.66	--	.12	2	.11
<i>Melanoplus lakinus</i> Scudd.	--	--	.66	.40	.26	--	.12	2	.11
<i>Melanoplus mexicanus</i> Sauss.	--	--	18.74	15.65	17.20	.15	.44	66	3.80
<i>Melanoplus packardi</i> Scudd.	--	14.18	17.00	.40	.15	13.20	3.65	16.47	16.36
<i>Melanoplus</i> spp. (nymphs)	--	--	--	9.80	--	2.41	.56	27	5.59
<i>Mermiria maculipennis</i> Rehn	--	--	.65	.41	.25	13.40	13.92	240	13.83
<i>Mestobregma kiowa</i> Thos.	--	--	.49	--	.40	--	.17	4	.23
<i>Metator pardalinus</i> Sauss.	--	--	.65	--	.53	--	.23	4	.23
<i>Opeia obscura</i> Thos.	--	--	.33	.21	.13	--	.12	2	.11
<i>Phlibostroma quadrimaculatum</i> Thos.	2.12	--	.92	--	.48	--	.75	13	.75
<i>Spharagemon collare</i> Scudd.	--	--	1.25	.60	.52	--	1.10	19	1.09
<i>Spharagemon equale</i> Say	--	.51	.60	--	.83	--	.34	13	.75
<i>Trimerotropis campestris</i> McNeill	--	--	.10	.20	--	--	.05	.6	.34
<i>Trimerotropis laticeincta</i> Sauss.	--	--	--	--	--	--	--	1	.06
Numbers collected	614	967	499	--	--	757	164	1,708	1,735

The percentages of individuals of the various species present in the State of Colorado, arranged according to crops infested, were as follows:

Corn

Percent

1. *Melanoplus mexicanus*-----18
2. *Melanoplus packardii*-----14
3. *Aeoloplus turnbullii*-----12
4. *Melanoplus angustipennis*---- 8
5. *Melanoplus lakinus*----- 7
6. Twenty-six other species----41

Small grain

Percent

1. *Melanoplus mexicanus*-----15
2. *Melanoplus bivittatus*-----12
3. *Aeoloplus turnbullii*----- 9
4. *Melanoplus angustipennis*---- 8
5. *Melanoplus packardii*----- 7
6. Twenty-three other species---49

Legumes

1. *Melanoplus femur-rubrum*-----46
2. *Melanoplus mexicanus*-----17
3. *Melanoplus bivittatus*----- 9
4. *Aeoloplus turnbullii*----- 4
5. *Melanoplus differentialis*---- 3
6. Nine other species-----21

Pasture

1. *Melanoplus bivittatus*-----16
2. *Melanoplus mexicanus*-----13
3. *Melanoplus femur-rubrum*----- 5
4. *Melanoplus lakinus*----- 5
5. *Aeoloplus turnbullii*----- 4
6. Twenty-six other species-----57

Row

1. *Melanoplus femur-rubrum*-----37
2. *Melanoplus bivittatus*-----24
3. *Ageneotettix deorum*----- 5
4. *Melanoplus lakinus*----- 4
5. *Melanoplus mexicanus*----- 3
6. Five other species-----27

Roadside

1. *Melanoplus mexicanus*-----16
2. *Melanoplus femur-rubrum*-----16
3. *Melanoplus bivittatus*-----10
4. *Aeoloplus turnbullii*----- 8
5. *Melanoplus packardii*----- 5
6. Thirty-one other species-----45

Grand total

Percent

1. *Melanoplus femur-rubrum*----17
2. *Melanoplus mexicanus*-----16
3. *Melanoplus bivittatus*-----10
4. *Aeoloplus turnbullii*----- 8
5. *Melanoplus packardii*----- 5
6. Thirty-one other species---44

MICHIGAN

There are but three natural vegetation areas in Michigan--the northeastern pine forest, northeastern hardwoods, and southern hardwoods. Large portions of these areas have been denuded of their forests and in their stead there is now an abundance of stump pasture land and small farms.

No collections are recorded for the Lower Peninsula. In the Upper Peninsula 985 specimens were taken, representing 8 species in 3 environments, viz., 8 in pastures, 1 in small grain, and 3 in legumes. The infestations were light over the entire Upper Peninsula, but severe infestations were present in the northern half of the Lower Peninsula. *Melanoplus mexicanus* and *Cannula pellucida* were the most important species. The general population in 1936 was about half that recorded for 1935.

The distribution by species of 985 specimens collected in the Upper Peninsula of Michigan, expressed in percentage of total number collected in each habitat, is shown in the following table.

Species	Percentage collected in --			Total speci- mens	% of grand total
	Pasture	Small grain	Legumes		
<i>Cannula pellucida</i>	29.05	100	--	321	32.58
<i>Chortippus curtipennis</i>	.56	--	2.94	6	.61
<i>Melanoplus bivittatus</i>	.79	--	--	7	.71
<i>Melanoplus confusus</i> Scudd.	.11	--	--	1	.10
<i>Melanoplus dawsoni</i>	1.02	--	--	9	.94
<i>Melanoplus differentialis</i>	.24	--	--	2	.20
<i>Melanoplus femur-rubrum</i>	10.58	--	67.64	117	11.88
<i>Melanoplus mexicanus</i>	57.65	--	29.42	522	52.99
Numbers collected	888	63	34	985	--

The percentages of individuals of the various species present in Michigan, arranged according to crops infested, are summarized as follows:

<u>Pasture</u>	<u>Percent</u>	<u>Small grain</u>	<u>Percent</u>
1. <i>Melanoplus mexicanus</i> -----	57	1. <i>Cannula pellucida</i> -----	100
2. <i>Cannula pellucida</i> -----	29		
3. <i>Melanoplus femur-rubrum</i> -----	10		
4. <i>Melanoplus dawsoni</i> -----	1		
5. <i>Melanoplus bivittatus</i> -----	1		
6. Three other species-----	2		
		<u>Legumes</u>	
		1. <i>Melanoplus femur-rubrum</i> -----	68
		2. <i>Melanoplus mexicanus</i> -----	29
		3. <i>Chortippus curtipennis</i> -----	3

Grand total

	<u>Percent</u>
1. <i>Melanoplus mexicanus</i> -----	53
2. <i>Camnula pellucida</i> -----	32
3. <i>Melanoplus femur-rubrum</i> -----	12
4. <i>Melanoplus dawsoni</i> -----	1
5. <i>Melanoplus bivittatus</i> -----	1
6. Three other species-----	1

MINNESOTA

The tall-grass prairie section, which comprises the extreme western and southern portions of this State, has been the most concerned with grasshopper outbreaks. All of the collections recorded were made in the extreme northwestern counties, or Red River Valley area. Three thousand three hundred and fourteen specimens, representing 26 species, were taken from 8 crop environments, as follows: 6 in corn, 17 in small grains, 14 in legumes, 13 in flax, 21 in meadows, 12 in pastures, 21 in mixed habitats, and 15 along roadsides.

The most severe infestations were observed in northwestern Minnesota. A normal-plus infestation was used to designate a somewhat general infestation in the central, west-central, and southern counties.

Cannula pellucida and Melanoplus bivittatus were the most important species. M. femur-rubrum was the most destructive species in the southern half of the State and appears to be increasing in numbers and importance. M. dawsoni and Encoptolophus costalis Scudd. were also relatively abundant. The distribution by species of 3,314 specimens collected in the Red River Valley of Minnesota, expressed in percentage of total number collected in each habitat, is shown in the following table.

The percentages of individuals of the various species present in Minnesota, arranged according to habitat, were as follows:

Corn

	<u>Percent</u>
1. <i>Cannula pellucida</i>	45
2. <i>Melanoplus bivittatus</i>	26
3. <i>Melanoplus dawsoni</i>	21
4. <i>Melanoplus mexicanus</i>	4
5. <i>Melanoplus femur-rubrum</i>	3
6. <i>Encoptolophus costalis</i>	1

Legumes

1. <i>Melanoplus femur-rubrum</i>	34
2. <i>Melanoplus mexicanus</i>	22
3. <i>Cannula pellucida</i>	12
4. <i>Melanoplus bivittatus</i>	8
5. <i>Encoptolophus costalis</i>	6
6. Ten other species	18

Meadow

1. <i>Cannula pellucida</i>	25
2. <i>Melanoplus dawsoni</i>	16
3. <i>Encoptolophus costalis</i>	12
4. <i>Melanoplus mexicanus</i>	11
5. <i>Melanoplus femur-rubrum</i>	9
6. Seventeen other species	27

Mixed

1. <i>Cannula pellucida</i>	17
2. <i>Melanoplus bivittatus</i>	17
3. <i>Melanoplus mexicanus</i>	16
4. <i>Melanoplus femur-rubrum</i>	11
5. <i>Melanoplus dawsoni</i>	9
6. Sixteen other species	30

Small grain

	<u>Percent</u>
1. <i>Melanoplus bivittatus</i>	41
2. <i>Cannula pellucida</i>	16
3. <i>Melanoplus femur-rubrum</i>	14
4. <i>Melanoplus mexicanus</i>	9
5. <i>Melanoplus dawsoni</i>	7
6. Twelve other species	13

Flax

1. <i>Melanoplus bivittatus</i>	52
2. <i>Melanoplus femur-rubrum</i>	19
3. <i>Cannula pellucida</i>	10
4. <i>Melanoplus dawsoni</i>	8
5. <i>Melanoplus mexicanus</i>	6
6. Six other species	5

Pasture

1. <i>Encoptolophus costalis</i>	34
2. <i>Cannula pellucida</i>	32
3. <i>Melanoplus femur-rubrum</i>	13
4. <i>Mestobregma kiowa</i>	8
5. <i>Ageneotettix deorum</i>	4
6. Seven other species	9

Roadside

1. <i>Cannula pellucida</i>	41
2. <i>Melanoplus bivittatus</i>	17
3. <i>Dissosteira carolina</i>	16
4. <i>Melanoplus mexicanus</i>	8
5. <i>Encoptolophus costalis</i>	5
6. Ten other species	13

Grand total

Percent

1. <i>Cannula pellucida</i>	23
2. <i>Melanoplus bivittatus</i>	18
3. <i>Melanoplus femur-rubrum</i>	12
4. <i>Melanoplus mexicanus</i>	11
5. <i>Melanoplus dawsoni</i>	10
6. Twenty-one other species	26

MONTANA

The three natural vegetation areas of this State are the short-grass, foothill, and mountain areas. Most of the localities troubled by grasshoppers are in the eastern two-thirds of the State, which is largely the short-grass area. The chief crop is wheat, with large grazing tracts. In the farming sections there is always an abundance of idle or abandoned land which is considered as a habitat when making grasshopper collections or studies of grasshopper populations.

There were 9,616 specimens, representing 46 species, collected in 11 habitats, viz., 30 in small grain, 23 in alfalfa and sweetclover, 37 on plains grasslands, 18 in low-mountain grasslands, 16 in sagebrush flats, 19 in native pastures, 25 in coulee bottoms, 9 in timothy hay, 29 along the roadsides, and 30 in the reversion and idle lands.

Melanoplus mexicanus was dominant in the State, with Aulocara elliotti second in importance. The most notable change was the great increase in abundance of A. elliotti which, in the range lands, came from fourth place at 10 percent in 1935, to first place at 28 percent of the total number of specimens collected in 1936. On the other hand, Cordillacris crenulata Brun., which held first place on the range in 1935 at 15 percent, dropped to eighth place at 3 percent. Amphitornus coloradus is another species that decreased greatly.

The most severe infestations were scattered all through the eastern two-thirds of the State, except for the north-central part, where local infestations occurred. Along the Yellowstone Valley and east of Billings heavy adult populations in July and August seemed to disappear suddenly in August, leaving no eggs. On the Huntley study area near Billings, the number of egg pods averaged eight per square foot in alfalfa and three in small grain in 1935. In 1936 there were more adults than in 1935; however, the egg counts in the egg survey of 1936, showed an average of only 0.13 per square foot in alfalfa and 0.07 in the small grain.

During the severe outbreaks grasshoppers tend to increase in numbers far beyond the carrying capacity of the plant food in a unit area. This causes a high mortality, which reduces the population to below the carrying capacity. Other factors, such as heat and drought, directly or indirectly help in this reduction by incapacitating the hoppers or fixing the carrying capacity at much lower levels than normal. The distribution by species of 9,616 individuals collected in Montana, expressed in total number taken in each habitat, is shown in the following table.

Species	Percentage collected in --								% of grand total	
	Alfalfa and sweet clover	Plains grass-land	Low Mt. grass-land	Sage-brush	Pas-ture	Cou-lee-boot-ton	Timo-tay	Road-side	Rever-sion	Total speci-mens
Small grain	0.19	0.48	--	17.59	0.52	0.25	--	1.93	--	123
Aeoloplus turnbullii	0.17	0.13	--	--	--	--	0.08	0.07	13	1.27
Aerochoreutes carlinianus Thos.	1.13	1.42	16.24	5.53	7.72	6.00	20.17	2.37	553	.13
Ageneotettix deorum	1.58	1.13	2.02	0.37	0.21	0.26	0.49	3.16	59	5.75
Amphitornus coloradus	0.06	--	--	0.07	0.74	--	--	0.96	--	.61
Arphia pseudonietana	--	--	2.20	27.81	11.81	23.17	12.00	--	3	.03
Aulocara elliotti	10.18	6.80	10.87	3.27	8.86	12.23	20.09	8.69	17.10	13.36
Cannula pellucida	0.04	0.06	--	--	6.26	--	--	10.08	.96	7.53
Chortippus curtipennis	--	--	--	--	--	--	--	--	724	.27
Cordillacris crenulata Brun.	--	--	2.99	--	--	1.72	--	.32	--	.58
Cordillacris occipitalis Thos.	--	--	2.00	--	--	--	--	.14	56	.03
Cratypedes neglectus Thos.	0.04	--	0.06	0.07	--	--	--	--	3	.02
Derotmema haydenii	0.04	0.06	0.97	0.97	--	--	--	--	2	.12
Dissosteira carolina	1.75	0.08	0.06	0.06	1.11	--	--	--	80	.83
Drepanopterna femoratum	--	--	0.06	0.06	0.85	2.35	25.00	--	77	.07
Encyrtolophus costalis	--	0.08	0.06	0.06	--	--	4.43	--	12	.12
Gomphocerus clavatus Thos.	--	--	0.06	0.06	--	--	--	.24	59	.02
Hadrotettix trifasciatus	--	0.17	--	0.83	1.47	--	--	--	44	.02
Hesperotettix viridis	--	1.13	--	1.25	4.50	--	74	--	24	.24
Hypochlora alba	--	0.04	--	0.13	2.21	--	1.72	--	51	.53
Melanoplus angustipennis	--	--	0.19	--	--	0.49	--	.08	16	.16
Melanoplus bivittatus	5.79	4.79	--	6.64	1.93	7.83	5.13	4.11	23	.23
Melanoplus bowditchi	--	--	0.56	--	5.57	2.26	3.44	--	63	.65
Melanoplus confusus	--	0.35	--	0.14	4.29	2.61	--	.16	340	3.53
Melanoplus dawsoni	--	--	0.52	--	0.37	--	74	1.97	48	.49
Melanoplus femur-rubrum	--	7.86	24.45	0.20	3.86	2.14	0.07	--	11	.11
Melanoplus flavidus	--	--	0.06	0.14	--	--	0.47	--	6	.06
Melanoplus gladstoni	--	--	1.79	77	10.03	5.17	--	.16	16	.16
Melanoplus infantilis	54.96	48.72	10.03	41.69	15.23	36.01	19.43	4.34	321	3.34
Melanoplus mexicanus	--	--	0.06	6.06	1.47	1.71	1.04	52.14	3898	40.54
Melanoplus occidentalis	--	0.08	3.62	2.85	1.85	1.28	2.87	1.97	1.61	1.42
Melanoplus packardii	--	0.06	--	0.76	--	--	--	7.87	12.05	5.69
Mermiria maculipennis	--	--	26	--	--	--	--	--	548	.12
Mestobregma kiowa	--	--	6.83	1.11	--	.26	--	.25	122	.12
Metator pardalinus	--	--	36	--	0.07	0.37	--	.26	62	.64

Species	Percentage collected in --										% of grand total	
	Alfalfa and sweet clover	Plains grass-land	Low Mt. Grass-land	Sage brush	Pas-ture	Cou-lee bot-ton	Timo-thy	Road-side	Rever-sion	Total speci-mens		
Opeia obscura	--	0.07	--	--	0.26	--	0.16	--	4	4	.04	
Orphulella pelidna	--	--	--	--	--	--	0.08	--	2	2	.02	
Orphulella speciosa	--	0.09	--	--	--	--	--	--	3	3	.03	
Phlibostroma quadrivalvatum	--	--	0.07	--	--	--	--	--	36	36	.37	
Phoetaliotes nebrascensis Thos.	.05	--	2.50	--	--	1.47	--	--	9	9	.09	
Schistocerca lineata Scudd.	--	--	0.06	--	--	1.23	--	--	6	6	.06	
Spharagemon collare	--	--	0.145	--	0.42	0.47	--	.16	59	32	.33	
Spharagemon equale	--	--	0.39	--	0.37	--	--	.08	59	26	.27	
Trimerotropis pestinaria Sanss.	--	--	0.27	--	--	--	--	--	1	1	.01	
Trimerotropis campestris--	--	--	--	0.07	--	--	--	.08	7	3	.03	
Trimerotropis pallidipennis	--	--	--	--	--	--	--	--	4	4	.04	
Burn. --	--	--	--	--	--	--	--	--	3	3	.03	
Trimerotropis sparsa Thos.--	--	--	--	--	--	--	--	--	22	22	.03	
Numbers collected	2,276	1,545	1,434	271	466	383	406	253	1,238	1,344	9,616	--

The percentages of individuals of the various species present in Montana, arranged according to habitat, were as follows:

Small grain

Percent

1. <i>Melanoplus mexicanus</i> -----	55
2. <i>Aulocara ellioti</i> -----	10
3. <i>Melanoplus femur-rubrum</i> -----	8
4. <i>Cannula pellucida</i> -----	7
5. <i>Melanoplus packardii</i> -----	6
6. Twenty-five other species-----	14

Plains grassland

1. <i>Aulocara ellioti</i> -----	28
2. <i>Ageneotettix deorum</i> -----	16
3. <i>Melanoplus mexicanus</i> -----	10
4. <i>Melanoplus infantilis</i> -----	10
5. <i>Mesobregma kiowa</i> -----	7
6. Thirty-six other species-----	29

Sagebrush

1. <i>Aulocara ellioti</i> -----	23
2. <i>Aeoloplus turnbulli</i> -----	18
3. <i>Melanoplus mexicanus</i> -----	15
4. <i>Cannula pellucida</i> -----	12
5. <i>Ageneotettix deorum</i> -----	8
6. Eleven other species-----	24

Coulee bottom

1. <i>Aulocara ellioti</i> -----	26
2. <i>Ageneotettix deorum</i> -----	20
3. <i>Melanoplus mexicanus</i> -----	19
4. <i>Drepanopterna femoratum</i> -----	4
5. <i>Melanoplus packardii</i> -----	8
6. Twenty other species-----	23

Roadside

1. <i>Melanoplus mexicanus</i> -----	34
2. <i>Aulocara ellioti</i> -----	17
3. <i>Cannula pellucida</i> -----	10
4. <i>Melanoplus femur-rubrum</i> -----	9
5. <i>Melanoplus packardii</i> -----	7
6. Twenty-four other species-----	23

Legumes

Percent

1. <i>Melanoplus mexicanus</i> -----	49
2. <i>Melanoplus femur-rubrum</i> -----	24
3. <i>Cannula pellucida</i> -----	11
4. <i>Melanoplus bivittatus</i> -----	5
5. <i>Melanoplus packardii</i> -----	4
6. Nineteen other species-----	7

Low-mountain grassland

1. <i>Melanoplus mexicanus</i> -----	42
2. <i>Aulocara ellioti</i> -----	12
3. <i>Cannula pellucida</i> -----	9
4. <i>Melanoplus femur-rubrum</i> -----	9
5. <i>Melanoplus bivittatus</i> -----	7
6. Thirteen other species-----	21

Pasture

1. <i>Melanoplus mexicanus</i> -----	36
2. <i>Cannula pellucida</i> -----	20
3. <i>Aulocara ellioti</i> -----	12
4. <i>Melanoplus bivittatus</i> -----	8
5. <i>Chortippus curtipennis</i> -----	6
6. Fourteen other species-----	18

Timothy

1. <i>Melanoplus mexicanus</i> -----	52
2. <i>Cannula pellucida</i> -----	20
3. <i>Aulocara ellioti</i> -----	9
4. <i>Melanoplus bivittatus</i> -----	5
5. <i>Melanoplus infantilis</i> -----	4
6. Four other species-----	10

Reversion

1. <i>Melanoplus mexicanus</i> -----	60
2. <i>Melanoplus packardii</i> -----	12
3. <i>Aulocara ellioti</i> -----	7
4. <i>Ageneotettix deorum</i> -----	4
5. <i>Melanoplus femur-rubrum</i> -----	3
6. Twenty-five other species-----	14

Grand total

Percent

1. <i>Melanoplus mexicanus</i> -----	41
2. <i>Aulocara ellioti</i> -----	13
3. <i>Melanoplus femur-rubrum</i> -----	8
4. <i>Cannula pellucida</i> -----	7
5. <i>Ageneotettix deorum</i> -----	6
6. Forty-one other species-----	25

NORTH DAKOTA

There are two natural vegetation areas in this State, the tall grass and short grass. Most of the collections came from the western half or short-grass area.

There were 9,972 specimens taken from 8 habitats and these represented 36 species, viz., 14 in corn, 25 in small grain, 16 in alfalfa and sweetclover, 17 in flax, 24 in range lands, 20 in coulees, 19 in idle and reverted lands, and 33 from along roadsides.

The most severe infestations occurred in the western half of the State. Other severe outbreaks occurred in the north-central part and the southeastern quarter.

Melanoplus mexicanus in North Dakota reached its greatest importance in relation to other species from the standpoint of numbers. It was the most important grasshopper in all crops forming over half (54 percent) of the 9,972 specimens collected. From 60 to 70 percent of the hoppers in small grain, alfalfa, and flax were of this species. Only on the range land was it second in importance, for here Ageneotettix deorum was dominant and three times as numerous as M. mexicanus. In reverted or idle lands M. mexicanus formed 59 percent of the population. This has been observed before, both here and in Montana, and bears out the fact that these are good habitats for this particular species. This species has increased its dominancy in crops over other species, and A. deorum has done the same on range lands. This would indicate that these two species are better able to withstand drought. Phlibostroma quadrimaculatum Thos., a common species, and others had fallen off in numbers.

The distribution by species of 9,972 individuals collected in North Dakota, expressed in percentage of total number taken in each habitat, is shown in the following table.

The percentages of individuals of the various species present in North Dakota, arranged according to habitat, were as follows:

Corn

Percent

1. <i>Melanoplus mexicanus</i> -----	44
2. <i>Melanoplus bivittatus</i> -----	24
3. <i>Melanoplus femur-rubrum</i> -----	9
4. <i>Melanoplus packardii</i> -----	7
5. <i>Dissosteira carolina</i> -----	3
6. Nine other species-----	13

Small grain

Percent

1. <i>Melanoplus mexicanus</i> -----	66
2. <i>Ageneotettix deorum</i> -----	9
3. <i>Melanoplus packardii</i> -----	7
4. <i>Dissosteira carolina</i> -----	3
5. <i>Aulocara ellioti</i> -----	2
6. Twenty other species-----	13

Legumes

1. <i>Melanoplus mexicanus</i> -----	68
2. <i>Melanoplus femur-rubrum</i> -----	6
3. <i>Camnula pellucida</i> -----	6
4. <i>Melanoplus packardii</i> -----	6
5. <i>Ageneotettix deorum</i> -----	4
6. Eleven other species-----	10

Flax

1. <i>Melanoplus mexicanus</i> -----	71
2. <i>Melanoplus femur-rubrum</i> -----	8
3. <i>Melanoplus bivittatus</i> -----	6
4. <i>Camnula pellucida</i> -----	3
5. <i>Melanoplus packardii</i> -----	2
6. Twelve other species-----	10

Range

1. <i>Ageneotettix deorum</i> -----	47
2. <i>Melanoplus mexicanus</i> -----	16
3. <i>Melanoplus infantilis</i> -----	9
4. <i>Phlibostroma quadrimaculatum</i> --	8
5. <i>Mestobregma kiowa</i> -----	6
6. Nineteen other species-----	14

Coulee

1. <i>Ageneotettix deorum</i> -----	50
2. <i>Melanoplus mexicanus</i> -----	19
3. <i>Aulocara ellioti</i> -----	15
4. <i>Melanoplus infantilis</i> -----	4
5. <i>Melanoplus packardii</i> -----	3
6. Fifteen other species-----	9

Reversion

1. <i>Melanoplus mexicanus</i> -----	59
2. <i>Ageneotettix deorum</i> -----	16
3. <i>Melanoplus packardii</i> -----	8
4. <i>Melanoplus angustipennis</i> -----	7
5. <i>Melanoplus infantilis</i> -----	2
6. Fourteen other species-----	8

Roadside

1. <i>Melanoplus mexicanus</i> -----	52
2. <i>Ageneotettix deorum</i> -----	9
3. <i>Melanoplus angustipennis</i> -----	7
4. <i>Melanoplus femur-rubrum</i> -----	7
5. <i>Melanoplus packardii</i> -----	7
6. Twenty-eight other species---	18

Grand total

Percent

1. <i>Melanoplus mexicanus</i> -----	54
2. <i>Ageneotettix deorum</i> -----	15
3. <i>Melanoplus packardii</i> -----	6
4. <i>Melanoplus angustipennis</i> -----	4
5. <i>Melanoplus femur-rubrum</i> -----	4
6. Thirty-one other species-----	17

SOUTH DAKOTA

Most of the collections in this State were made in the short-grass area. There were 5,122 specimens taken in 7 environments, with 39 species represented, viz., 21 in corn, 27 in small grain, 35 on range land, 22 in legumes, 23 in pastures and hay meadows, 5 in flax, and 10 from roadsides.

Very little can be said regarding the locations of the infestations as the whole State was subjected to extreme heat and drought, which reduced egg deposition enormously, close to 100 percent in many places. During the adult survey in July and August infestations were general and severe. In 36 counties no eggs were found in the egg survey and all counties averaged under 10 percent.

Melanoplus mexicanus was the most numerous in all crops, also on the range and in the pastures. It constituted 48 percent of the total number of specimens collected in the State. M. femur-rubrum was second, M. differentialis third, and Ageneotettix deorum fourth. In 1935, A. deorum and Mesobregma kiowa were the two most important species on the range and in the pastures. They have been superseded by M. mexicanus in these habitats, which has increased its lead over the others. Phlibostroma quadrimaculatum and Amphiternus coloradus, with others, have decreased where, in 1935, they were among the first five species in numbers in some of the habitats. The distribution by species of 5,122 individuals collected in South Dakota, expressed in percentage of the total number taken in each habitat, is shown in the following table.

Species	Percentage collected in --						Total speci- mens	% of grand total
	Corn	Small grains	Range	Leg- umes	Pasture & hay meadow	Flax		
<i>Aeoloplus turnbullii</i> - - -	0.40	0.76	0.90	--	--	--	28	0.54
<i>Aeneotettix deorum</i> - - -	10.05	4.33	14.95	7.89	15.94	2.09	488	9.52
<i>Amphitormus coloradus</i> - - -	--	--	.14	.10	1.61	--	12	.23
<i>Amphitormus pseudonietana</i> - - -	--	--	1.00	1.53	5.36	1.05	14	.27
<i>Aulocara elliotti</i> - - -	--	--	--	--	.20	--	124	2.42
<i>Brunneria brunnea Thos.</i> - - -	--	--	1.81	.19	.06	--	7	.13
<i>Carmula pellucida</i> - - -	--	--	--	--	.26	--	28	.55
<i>Chortippus cordillacris Harr.</i> - - -	--	--	1.40	1.21	1.50	--	7	.13
<i>Derotrema haydenii</i> - - -	--	--	.61	.64	3.59	3.51	47	.91
<i>Dissosteira carolina</i> - - -	--	--	--	.14	3.58	1.05	25	.49
<i>Drepanoptera femoratum</i> - - -	--	--	--	.25	.46	--	66	1.29
<i>Encyrtolophus costalis</i> - - -	--	--	--	.25	.46	--	10	.20
<i>Hadrotettix trifasciatus</i> - - -	--	--	.61	.25	.46	--	16	.32
<i>Esperotettix viridis</i> - - -	--	--	--	--	.12	--	14	.28
<i>Hypochlora alba</i> - - -	--	--	2.02	--	.20	--	2	.04
<i>Melanoplus angustipennis</i> - - -	--	--	4.84	1.08	1.76	--	2	.11
<i>Melanoplus bivittatus</i> - - -	--	--	--	.14	.20	--	109	.21
<i>Melanoplus bowditchi</i> - - -	--	--	--	.25	--	--	6	.12
<i>Melanoplus confusus</i> - - -	--	--	27.74	.76	4.83	--	4	.08
<i>Melanoplus differentialis</i> - - -	--	--	5.23	16.31	4.50	3.00	285	5.56
<i>Melanoplus femur-rubrum</i> - - -	--	--	--	--	25.97	84	635	12.39
<i>Melanoplus flavidus</i> - - -	--	--	--	--	.09	--	1	.02
<i>Melanoplus foedus Scudd.</i> - - -	--	--	1.42	1.08	3.72	--	81	1.58
<i>Melanoplus gladstoni</i> - - -	--	--	--	.65	.12	--	16	.32
<i>Melanoplus infantilis</i> - - -	--	--	.61	.38	.97	--	24	.47
<i>Melanoplus lakinus</i> - - -	--	--	--	.19	.72	--	14	.27
<i>Melanoplus mexicanus</i> - - -	--	--	35.78	58.67	46.30	49.25	56.13	47.97
<i>Melanoplus occidentalis</i> - - -	--	--	--	2.17	.46	--	62.46	.80
<i>Melanoplus packardii</i> - - -	--	--	2.82	5.22	1.63	.69	10.41	142
<i>Melanoplus spp. (nymphs)</i> - - -	--	--	--	1.40	.72	1.08	7.29	2.77
<i>Memirria maculipennis</i> - - -	--	--	.20	--	--	--	1.04	1.10
<i>Mestobregma kiowa</i> - - -	--	--	1.62	--	1.24	2.16	1.04	1.49
<i>Metator pardalinus</i> - - -	--	--	.61	--	.12	10.00	1.04	.30
<i>Opeia obscura</i> - - -	--	--	--	--	.12	.54	15	.04
<i>Orphulella speciosa</i> - - -	--	--	--	--	.12	3.21	2	.25
<i>Phlibostroma quadrimaculatum</i> - - -	--	--	--	--	1.37	--	23	.45
<i>Phoetaliotes nebrascensis</i> - - -	--	--	.61	.39	.20	14.58	68	1.34
<i>Schistocerca lineata</i> - - -	--	--	--	--	.06	1.35	1	.02
<i>Spharagemon collare</i> - - -	--	--	1.02	1.15	.33	--	8.35	1.05
<i>Spharagemon equale</i> - - -	--	--	.40	.52	1.83	.09	54	.76
Numbers collected - - -	497	1,569	1,532	1001	370	57	96	5,122

The percentages of individuals of the various species present in South Dakota arranged according to habitat, were as follows:

Corn

Percent

1. *Melanoplus mexicanus*-----36
2. *Melanoplus differentialis*----27
3. *Ageneotettix deorum*-----10
4. *Melanoplus femur-rubrum*----- 5
5. *Melanoplus bivittatus*----- 4
6. Seventeen other species-----18

Range

1. *Melanoplus mexicanus*-----46
2. *Ageneotettix deorum*-----15
3. *Aulocara ellioti*----- 5
4. *Melanoplus differentialis*---- 4
5. *Melanoplus femur-rubrum*----- 4
6. Thirty-one other species-----26

Pasture

1. *Melanoplus mexicanus*-----17
2. *Ageneotettix deorum*-----16
3. *Phoetaliotes nebrascensis*----14
4. *Mesoboreagma kiowa*-----10
5. *Melanoplus differentialis*---- 8
6. Nineteen other species-----35

Roadside

1. *Melanoplus mexicanus*-----62
2. *Melanoplus packardii*-----10
3. *Spharageman collare*----- 8
4. *Melanoplus* spp. (nymphs)---- 7
5. *Hadrotettix trifasciatus*----- 4
6. Five other species----- 9

Small grain

Percent

1. *Melanoplus mexicanus*-----58
2. *Melanoplus femur-rubrum*-----16
3. *Melanoplus packardii*----- 5
4. *Ageneotettix deorum*----- 4
5. *Aulocara ellioti*----- 1
6. Twenty-three other species---16

Legumes

1. *Melanoplus mexicanus*-----49
2. *Melanoplus femur-rubrum*-----26
3. *Ageneotettix deorum*----- 8
4. *Melanoplus angustipennis*---- 4
5. *Melanoplus differentialis*---- 3
6. Eighteen other species-----10

Flax

1. *Melanoplus mexicanus*-----56
2. *Melanoplus femur-rubrum*-----36
3. *Dissosteira carolina*----- 4
4. *Arphia pseudonietana*----- 2
5. *Aeoloplus turnbullii*----- 2

Grand total

1. *Melanoplus mexicanus*-----48
2. *Melanoplus femur-rubrum*-----12
3. *Ageneotettix deorum*----- 9
4. *Melanoplus differentialis*---- 5
5. *Melanoplus packardii*----- 3
6. Thirty-five other species----23

UTAH

This State lies in the northern desert-shrub area, with mostly irrigated farms. Alfalfa is one of the principal crops. In Utah 3,572 specimens were collected in 5 habitats, representing between 35 and 40 species. Several species of Trimerotropis were lumped together because their identity was not certain. Of the species collected, 27 were taken in alfalfa, 30 in mixed habitats, 15 on the range, 10 in small grains, and 16 in meadows.

The most severe infestations were found in the north-central part of the State. In most areas the populations had increased considerably over those of 1935. The most numerous species was Melanoplus femur-rubrum, with M. mexicanus second, M. packardii third, and Aulocara elliotti fourth. In 1935, M. mexicanus was first, with M. femur-rubrum second, but in 1936 their positions were changed. Trimerotropis vinculata Scudd. was third in numbers in 1935, at 17 percent of the total number of specimens collected for the State. In 1936, it declined to only 0.72 percent of the total. A. elliotti increased from 0.64 percent in 1935 to 7.94 percent in 1936. The distribution by species of 3,572 individuals collected in Utah, expressed in percentage of total number taken in each habitat, is shown in the following table.

Species	Percentage collected in --					Total specimens	% of grand total
	Leg-worms	Mixed	Range	Small grain	Meadow		
<i>Aeoloplus tenuipennis</i> Scudd.	--	--	--	--	--	1	0.03
<i>Aeoloplus turnbulii</i> -	0.53	0.07	--	--	--	20	0.56
<i>Ageneotettix deorum</i> -	0.26	0.92	--	--	--	6	0.17
<i>Amphitornus coloradus</i> -	--	0.20	--	--	--	9	0.25
<i>Arphia pseudonietana</i> -	--	0.59	--	--	--	9	0.25
<i>Aulocara elliotti</i> -	0.35	0.26	--	1.06	--	284	7.94
<i>Cannula pellucida</i> -	3.15	15.24	8.84	--	0.47	185	5.18
<i>Chortippus curtipennis</i> -	1.14	3.22	3.40	8.34	17.16	47	1.32
<i>Circotettix undulatus</i> Rehn	1.14	0.26	--	--	14.68	5	0.14
<i>Conocephalus sp.</i> -	0.79	1.77	--	--	0.78	215	6.02
<i>Cordillacris occipitalis</i> -	--	--	--	--	27.92	1	0.03
<i>Cratypedes neglectus</i> -	0.17	--	--	--	0.16	1	0.06
<i>Derotmema haydeni</i> -	--	0.33	4.08	--	1.2	2	0.34
<i>Diassosteira carolina</i> -	1.58	1.71	1.37	3.12	0.94	55	1.54
<i>Diassosteira spurcata</i> Sauss. -	0.17	0.53	11.56	--	--	27	0.76
<i>Hesperotettix viridis</i> -	0.70	0.59	2.04	--	--	22	0.62
<i>Melanoplus bivittatus</i> -	9.03	6.90	11.56	6.26	4.20	259	7.25
<i>Melanoplus confusus</i> -	0.09	--	--	--	--	1	0.03
<i>Melanoplus dawsoni</i> -	--	0.07	--	--	--	1	0.03
<i>Melanoplus differentialis</i> -	--	0.07	--	--	34.32	1	0.03
<i>Melanoplus femur-rubrum</i> -	26.29	29.37	17.68	19.78	1016	9	28.45
<i>Melanoplus keeleri</i> Thos. -	--	0.59	--	--	--	623	0.25
<i>Melanoplus mexicanus</i> -	26.73	16.23	4.08	22.89	489	17.44	13.69
<i>Melanoplus packardii</i> -	19.98	14.85	3.40	22.89	1.25	15	0.42
<i>Mermiria maculipennis</i> -	0.18	0.20	--	--	--	14	0.39
<i>Mestobregma kiowa</i> Thos. -	0.53	0.20	--	1.06	0.62	74	2.07
<i>Mestobregma plattei</i> Thos. -	2.02	2.10	0.69	10.42	2.81	3	0.08
<i>Orphulella speciosa</i> -	--	--	--	--	0.47	12	0.34
<i>Schistocerca lineata</i> -	0.53	0.39	--	--	--	34	0.95
<i>Spharagemon collare</i> -	1.40	1.12	--	--	0.16	14	0.11
<i>Spharagemon equale</i> -	0.26	0.07	--	--	--	5	0.14
<i>Trimerotropis agrestis</i> McNeill -	0.26	--	1.37	--	--	63	1.76
<i>Trimerotropis laticincta</i> -	0.61	1.18	25.84	--	--	18	0.50
<i>Trimerotropis pallidipennis</i> -	0.79	0.26	0.69	4.18	--	26	0.72
<i>Trimerotropis vinculata</i> Scudd. -	1.23	0.46	3.40	--	--	5	0.14
<i>Trimerotropis sp.</i> -	0.09	0.25	--	--	--	5	0.14
Numbers collected -	1,141	1,522	147	%	641	3,572	---

The percentages of individuals of the various species present in Utah, arranged according to habitat, were as follows:

<u>Legumes</u>	<u>Percent</u>
1. <i>Melanoplus mexicanus</i> -----	27
2. <i>Melanoplus femur-rubrum</i> -----	26
3. <i>Melanoplus packardii</i> -----	20
4. <i>Aulocara elliotti</i> -----	3
5. <i>Dissosteira carolina</i> -----	2
6. Twenty-two other species-----	22

<u>Range</u>	
1. <i>Trimerotropis laticincta</i> -----	25
2. <i>Melanoplus femur-rubrum</i> -----	17
3. <i>Melanoplus bivittatus</i> -----	11
4. <i>Dissosteira spurcata</i> -----	11
5. <i>Aulocara elliotti</i> -----	8
6. Ten other species-----	28

<u>Meadow</u>	
1. <i>Melanoplus femur-rubrum</i> -----	34
2. <i>Conocephalus sp.</i> -----	28
3. <i>Cannula pellucida</i> -----	17
4. <i>Chortippus curtipennis</i> -----	5
5. <i>Melanoplus bivittatus</i> -----	4
6. Eleven other species-----	12

<u>Mixed</u>	<u>Percent</u>
1. <i>Melanoplus femur-rubrum</i> -----	29
2. <i>Melanoplus mexicanus</i> -----	16
3. <i>Aulocara elliotti</i> -----	15
4. <i>Melanoplus packardii</i> -----	14
5. <i>Melanoplus bivittatus</i> -----	7
6. Twenty-five other species-----	19

<u>Small grain</u>	
1. <i>Melanoplus mexicanus</i> -----	23
2. <i>Melanoplus packardii</i> -----	23
3. <i>Melanoplus femur-rubrum</i> -----	19
4. <i>Mestobregma plattei</i> -----	10
5. <i>Cannula pellucida</i> -----	8
6. Five other species-----	17

<u>Grand total</u>	
1. <i>Melanoplus femur-rubrum</i> -----	28
2. <i>Melanoplus mexicanus</i> -----	17
3. <i>Melanoplus packardii</i> -----	13
4. <i>Aulocara elliotti</i> -----	8
5. <i>Melanoplus bivittatus</i> -----	7
6. Thirty-one other species-----	27

WISCONSIN

The northeastern pine and northeastern and southern hardwood areas comprise most of this State. There are many cut-over stump pastures and hay meadows. With the exception of two spots, one in Ashland and one in Waupaga County, the most severe infestations were confined to the southern three tiers of counties. Heavy infestations of *Melanoplus femur-rubrum* and *M. mexicanus* developed in these counties. Considerable difficulty was encountered in finding eggs during the egg survey and it is believed that the heavy rains in the latter part of the summer checked the infestations.

M. femur-rubrum, at 65 percent, constituted two-thirds of the specimens collected in the State. *M. mexicanus* was second, at 31 percent. Twelve other species together made up the remainder at 4 percent. The numbers of nymphs of *M. femur-rubrum* ran as high as from 70 to 80 per square yard in July and serious damage was done to second cuttings and new seedings of alfalfa. From 1935 to 1936, *M. mexicanus* has reduced the lead that *M. femur-rubrum* had over it from 71 percent, in 1935, to 34 percent in 1936. The following table shows the distribution by species of 3,628 individuals taken in Wisconsin, expressed in percentage of the total number taken in each habitat.

Species	Percentage collected in --				Total speci- mens	% of grand total
	Pasture	Legumes	Roadside	Soy beans		
<i>Ageneotettix deorum</i>	--	0.15	--	2.47	6	0.18
<i>Cannula pellucida</i>	--	.34	--	--	51	1.40
<i>Chortippus curtipennis</i>	--	.76	--	--	6	.18
<i>Dissosteira carolina</i>	--	--	.04	--	1	.03
<i>Hesperotettix viridis</i>	--	--	.13	--	1	.03
<i>Melanoplus bivittatus</i>	--	--	.29	--	11	.30
<i>Melanoplus dawsoni</i>	--	.38	--	--	16	.44
<i>Melanoplus femur-rubrum</i>	--	.03	73.57	--	2,367	65.25
<i>Melanoplus keeleri luridus</i> Thos.	--	43.63	.18	--	5	.14
<i>Melanoplus mexicanus</i>	--	--	.18	--	1,125	30.46
<i>Mesobregma kiowa</i> Thos.	--	47.73	23.97	100	80.25	--
<i>Orphulella speciosa</i>	--	--	.62	--	17	.47
<i>Schistocerca lineata</i>	--	--	.62	--	17	.47
<i>Spharagemon collare</i>	--	--	.07	--	2	.06
Numbers collected	786	2,731	30	81	3,628	--
						140

The percentages of individuals of the various species present in Wisconsin, arranged according to habitat, were as follows:

<u>Pasture</u>	<u>Percent</u>
1. <i>Melanoplus mexicanus</i> -----	48
2. <i>Melanoplus femur-rubrum</i> -----	43
3. <i>Cannula pellucida</i> -----	5
4. <i>Melanoplus dawsoni</i> -----	2
5. <i>Chortippus curtipennis</i> -----	1
6. Two other species-----	1

<u>Roadside</u>	
1. <i>Melanoplus mexicanus</i> -----	100

<u>Legumes</u>	<u>Percent</u>
1. <i>Melanoplus femur-rubrum</i> -----	74
2. <i>Melanoplus mexicanus</i> -----	24
3. <i>Orphulella speciosa</i> -----	1
4. <i>Mestobregma kiowa</i> -----	1

<u>Soybeans</u>	
1. <i>Melanoplus mexicanus</i> -----	80
2. <i>Melanoplus femur-rubrum</i> -----	17
3. <i>Ageneotettix deorum</i> -----	3

Grand total

<u>Percent</u>
1. <i>Melanoplus femur-rubrum</i> -----65
2. <i>Melanoplus mexicanus</i> -----31
3. <i>Cannula pellucida</i> ----- 1
4. <i>Orphulella speciosa</i> ----- 1
5. <i>Mestobregma kiowa</i> ----- 1
6. Nine other species----- 1

WYOMING

In this State most of the collecting was confined to the northern desert-shrub or sagebrush area and the short-grass areas of the State. From two to seven times as many specimens were taken as in some other States, viz., 21,189 specimens from 9 habitats. These specimens represented 42 species, in habitats as follows: 30 in small grain, 37 in legumes, 22 in coulees, 26 along hillsides, 31 on range land, 25 in idle and reverted land, 25 along roadsides, and 24 in meadows. The heaviest infestations were in the irrigated sections of the northern and eastern two tiers of counties. Range losses were exceptionally heavy in the six northeastern counties. Populations had increased in the irrigated sections and decreased only on the range in the primary drought areas.

Melanoplus mexicanus was the most numerous species, with *M. femur-rubrum* second and *M. bivittatus* a close third. *Aulocara elliotti* and *Ageneotettix deorum* were about equal in numbers on the range lands. *M. packardii* was numerous in many places.

According to the collections, the most marked change from 1935 to 1936, has been the reduction in abundance of *Cannula pellucida*. In 1935 this species was dominant on the range land, at 23 percent, and was among the first five most

numerous species in five out of the six recorded habitats. It was also second in numbers, at 21 percent, to M. mexicanus, which was first, at 23 percent, in the total number of specimens collected for the State. In 1936 on the range C. pellucida formed only 0.17 percent of the hoppers and was seventh in numbers, at 4 percent of the total collected for the State. On the other hand, A. elliotti rose from fourth place on the range, at 6 percent in 1935, to first place, at 19 percent in 1936, and from seventh place, at 2 percent of the total number collected, to fourth place at 9 percent. M. mexicanus had increased its lead over the nearest competitors of 1935. On C. pellucida this increase was from 2 percent in 1935 to 22 percent in 1936; on M. bivittatus from 5 to 15 percent, and M. femur-rubrum from 7 to 12 percent. All these figures were computed on the basis of the total numbers of specimens collected in these years. The distribution by species of 21,189 specimens collected in Wyoming, expressed in percentage of total number taken in each habitat, is shown in the following table.

Species	Percentage collected in--										Total speci- mens	% of grand total
	Small grain	Leg- umes	Cou- lee	Hill- side	Range	River- sion	Road- side	Meadow	River bottom			
<i>Aeoloplus turnbullii</i> - - -	0.85	5.05	0.41	0.15	1.76	0.34	2.36	0.06	2.18	591	2.78	
<i>Ageneotettix deorum</i> - - -	5.22	1.76	19.51	28.26	17.84	6.61	5.44	30.54	7.73	1781	8.37	
<i>Amphitarnus coloradus</i> - - -	.14	.21	.41	2.00	1.61	.11	.20	.41	.84	106	.50	
<i>Arphia pseudonietana</i> - - -	.03	.01	--	.15	.04	.11	--	11.26	.04	6	.03	
<i>Aulocara elliotti</i> - - -	4.97	3.50	9.35	7.68	19.33	30.89	4.66	--	12.56	1809	8.50	
<i>Bruneria brumea</i> - - -	--	--	--	--	.29	--	.33	--	--	12	.05	
<i>Cannula pellucida</i> - - -	--	9.38	2.80	1.02	--	.17	2.74	5.38	10.57	5.00	899	
<i>Chortippus curtipennis</i> - -	--	--	.06	--	--	--	.06	--	.08	7	.03	
<i>Cordillacris crenulata</i> - -	--	--	.03	2.44	.46	--	--	--	.04	33	.16	
<i>Cratypedes neglectus</i> - -	--	.03	--	--	.53	.68	.46	.21	.13	1	.01	
<i>Derotnema haydenii</i> - - -	.52	.17	--	--	.15	.68	.59	.14	.17	61	.29	
<i>Diessosteira carolina</i> - -	.82	.42	--	--	.53	.68	.55	.21	.17	81	.38	
<i>Drepanopterna femorata</i> - -	.38	.22	1.42	1.54	6.65	.57	.85	2.21	.26	16	.07	
<i>Encyrtolophus costalis</i> - -	--	.05	--	--	--	--	--	--	.38	2	.01	
<i>Gomphocerus clavatus</i> - -	--	.04	--	--	--	--	--	--	--	407	.91	
<i>Hadrotettix trifasciatus</i> - -	--	.20	.13	--	1.23	--	.57	.06	.17	43	.20	
<i>Hesperotettix viridis</i> - -	.42	.19	--	--	7.68	1.53	2.39	.76	.08	149	.70	
<i>Hypochlora alba</i> - - -	--	--	--	--	.31	--	.06	--	.04	4	.08	
<i>Melanoplus angustipennis</i> - -	5.52	1.59	.41	.07	5.41	.80	10.76	.41	4.07	724	.19	
<i>Melanoplus bivittatus</i> - -	12.27	18.46	--	--	3.99	.45	.46	.48	.90	2384	.41	
<i>Melanoplus bowditchi</i> - -	.75	.01	1.02	--	7.53	1.61	--	.26	.14	131	.11	
<i>Melanoplus confusus</i> - -	--	--	.09	--	--	--	--	--	.38	8	.04	
<i>Melanoplus dawsoni</i> - -	--	--	.01	--	.31	.25	--	--	--	--	.04	
<i>Melanoplus differentialis</i> - -	.20	1.89	--	--	.08	.23	.66	--	.34	188	.89	
<i>Melanoplus femur-rubrum</i> - -	5.01	27.51	3.25	--	.15	1.32	1.03	9.18	2.49	3038	14.33	
<i>Melanoplus flavidus</i> - -	.78	.40	--	--	.15	.62	.16	.49	--	135	.63	
<i>Melanoplus gladstoni</i> - -	.52	.21	--	--	.63	1.37	.16	.59	.55	74	.35	
<i>Melanoplus infantilis</i> - -	2.42	1.14	5.08	--	.68	.36	2.36	.60	.08	478	2.25	
<i>Melanoplus keeleri luriidus Dodge</i> - -	.07	--	--	--	--	--	--	.33	--	7	.03	
<i>Melanoplus mexicanus</i> - -	40.58	22.99	13.21	23.96	13.59	39.44	22.70	30.68	32.05	5587	26.32	
<i>Melanoplus occidentalis</i> - -	.75	.39	1.83	--	.63	1.37	.16	.59	.55	230	1.09	
<i>Melanoplus packardii</i> - -	6.78	9.93	1.22	2.46	6.65	6.38	11.15	1.66	1.22	1503	7.09	
<i>Mernirria mucedupennis</i> - -	--	.01	--	--	--	--	.13	--	--	3	.01	
<i>Mestobregma kiowa</i> - - -	.10	.04	6.50	.80	1.03	.34	.20	.10	.59	90	.42	
<i>Metator pardalinus</i> - - -	.15	.13	1.63	.77	.67	.80	.07	.35	.55	69	.32	

Species	Percentage collected in--							Total speci- mens	% of grand total
	Small grain	Leg- umes	Cou- lee	Hill- side	Range	Rever- sion	Road- side		
<i>Opeia obscura</i>	--	0.02	28.85	0.61	.82	--	0.13	--	0.96
<i>Phlibostroma quadrivalvatum</i>	.15	.08	1.42	.61	4.09	--	.49	.07	.66
<i>Phoetaliotes nebrascensis</i>	.03	.05	.42	.15	.21	--	--	.34	.10
<i>Spharagemon collare</i>	--	.16	--	--	.87	.34	.92	.35	.38
<i>Spharagemon equale</i>	.24	.22	.20	.15	.21	.34	.20	.10	.31
<i>Trimerotropis picturata</i> Sauss.	--	--	.20	.15	.12	--	.06	.18	.03
<i>Trimerotropis pallidipennis</i>	--	.03	.20	--	--	--	.07	--	.02
Numbers collected	2,928	8,467	492	651	2,422	877	1,524	1,448	2,380
								21,189	--

The percentages of individuals of the various species present in Wyoming, arranged according to habitat, were as follows:

Small grain

Percent

1. <i>Melanoplus mexicanus</i> -----	41
2. <i>Melanoplus bivittatus</i> -----	12
3. <i>Cannula pellucida</i> -----	9
4. <i>Melanoplus packardii</i> -----	7
5. <i>Melanoplus angustipennis</i> -----	5
6. Twenty-five other species-----	26

Legumes

Percent

1. <i>Melanoplus femur-rubrum</i> -----	27
2. <i>Melanoplus mexicanus</i> -----	23
3. <i>Melanoplus bivittatus</i> -----	18
4. <i>Melanoplus packardii</i> -----	10
5. <i>Aeoloplus turnbulli</i> -----	5
6. Thirty-two other species-----	17

Coulee

1. <i>Opeia obscura</i> -----	29
2. <i>Ageneotettix deorum</i> -----	20
3. <i>Melanoplus mexicanus</i> -----	13
4. <i>Aulocara ellioti</i> -----	9
5. <i>Melanoplus infantilis</i> -----	5
6. Seventeen other species-----	24

Hillside

1. <i>Ageneotettix deorum</i> -----	28
2. <i>Melanoplus mexicanus</i> -----	24
3. <i>Aulocara ellioti</i> -----	8
4. <i>Hesperotettix viridis</i> -----	8
5. <i>Melanoplus bowditchi</i> -----	7
6. Twenty-one other species-----	25

Range

1. <i>Aulocara ellioti</i> -----	19
2. <i>Ageneotettix deorum</i> -----	18
3. <i>Melanoplus mexicanus</i> -----	14
4. <i>Drepanopterna femoratum</i> -----	7
5. <i>Melanoplus packardii</i> -----	7
6. Twenty-six other species-----	35

Reversion

1. <i>Melanoplus mexicanus</i> -----	39
2. <i>Aulocara ellioti</i> -----	31
3. <i>Ageneotettix deorum</i> -----	7
4. <i>Melanoplus packardii</i> -----	6
5. <i>Cannula pellucida</i> -----	3
6. Twenty other species-----	14

Roadside

1. <i>Melanoplus mexicanus</i> -----	23
2. <i>Melanoplus bivittatus</i> -----	15
3. <i>Melanoplus packardii</i> -----	11
4. <i>Melanoplus angustipennis</i> -----	10
5. <i>Melanoplus femur-rubrum</i> -----	9
6. Twenty-eight other species---	32

Meadow

1. <i>Melanoplus mexicanus</i> -----	31
2. <i>Ageneotettix deorum</i> -----	30
3. <i>Arphia pseudonietana</i> -----	11
4. <i>Cannula pellucida</i> -----	10
5. <i>Melanoplus infantilis</i> -----	6
6. Nineteen other species-----	12

River bottom

1. <i>Melanoplus mexicanus</i> -----	32
2. <i>Aulocara ellioti</i> -----	13
3. <i>Melanoplus femur-rubrum</i> -----	12
4. <i>Melanoplus bivittatus</i> -----	8
5. <i>Ageneotettix deorum</i> -----	7
6. Twenty-eight other species---	28

Grand total

1. <i>Melanoplus mexicanus</i> -----	26
2. <i>Melanoplus femur-rubrum</i> -----	14
3. <i>Melanoplus bivittatus</i> -----	11
4. <i>Aulocara ellioti</i> -----	9
5. <i>Ageneotettix deorum</i> -----	8
6. Thirty-seven other species---	32

ARIZONA

In general, the grasshopper populations were shown by the survey to be very low; however, in limited areas they were present in sufficient numbers for potential increase and spread to outbreak proportions. The most severe infestations were in Apache, Navajo, Coconino, Yavapai, and Gila Counties. The most important economic species were Melanoplus bivittatus, Cannula pellucida, and M. femur-rubrum.

ARKANSAS

The worst infestations were mostly in the northern two tiers of counties, which averaged from 5 to 10 percent infestation, 23 counties being involved in the State. The most important species in relation to crop damage was Melanoplus differentialis. Other prominent species were M. mexicanus, M. femur-rubrum, and M. impiger Scudd.

CALIFORNIA

The most severe infestations were in the north-central counties, as far north as Yuba County and south to Madera County. There were heavy infestations of Melanoplus mexicanus in the Imperial Valley, where two generations of this species occur annually. There were other spots of heavy infestation.

Based on damage to grazing land and cultivated crops, Cannula pellucida, M. mexicanus, and M. devastator Scudd. were about equally important, with M. marginatus Scudd. and M. femur-rubrum second in importance, and M. differentialis, Oedaleonotus enigma Scudd., O. borckii pacificus Scudd., and Hippiscus californicus Scudd. of somewhat less importance. M. devastator inhabits the foothills of the coast and the inland ranges of the Sierra Nevadas.

IDAHO

There were numerous small areas in which populations were slightly above normal in practically all of the counties of the State, with a definite increase in the grasshopper populations.

The most important species was Melanoplus femur-rubrum, with M. mexicanus second and M. bivittatus third.

ILLINOIS

The records were not complete for the individual survey stops. Most of the infestations were in a large area throughout the central part of the State, including most of the western boundary counties.

M. femur-rubrum, M. mexicanus, and M. differentialis were most numerous. M. differentialis probably did the most damage because it was concentrated on the corn, which is the most valuable crop attacked in this region.

IOWA

The most severe infestations occurred in the western and southern parts of the State, although the entire State was more or less involved.

In various districts of the State different species were of greatest importance. In the northwestern counties Melanoplus mexicanus was first and M. bivittatus second. In the west-central part there was more of a mixture of M. mexicanus, M. bivittatus, M. differentialis, and M. femur-rubrum. M. differentialis was more important in the southwestern district. In the south-central, central, and eastern sections M. femur-rubrum was dominant, with M. differentialis second in numbers. M. mexicanus had a partial second generation in 1936, which hatched out the last week of August.

The following is a list submitted by C. J. Drake. The grasshoppers were collected in Iowa in 1936 and determined by M. Hebard.

Pseudopomala brachytera Scudd., Woodbury County.

Mermiria maculipennis macclungi Rehn, Plymouth and Sioux Counties.

Syrbula admirabilis Uhl., Warren and Clark Counties.

Opeia obscura Thos., Sioux County.

Phlibostroma quadrimaculatum Thos., Sioux and Harrison Counties.

Orphulella speciosa Scudd., common to abundant in Clark, Union, Davis, Lyon, Plymouth, Adams, and Sioux Counties.

Orphulella pelidna Burm., Woodbury County.

Dichromorpha viridis Scudd., Davis, Story, Webster, and Woodbury Counties.

Chortippus longicornis Latr., Clay, Palo Alto, and Davis Counties (in swale).

Ageneotettix deorum deorum Scudd., abundant in pastures in Sioux, Adams, Lyon, Warren, Harrison, Woodbury, Clark, Crawford, Webster, and Plymouth Counties.

Arphia xanthoptera Germ., Warren, Clark, and Decatur Counties.

Arphia simplex Scudd., Sioux County.

Arphia pseudonietana Thos., Plymouth and Woodbury Counties.

Chortophaga viridifasciata Deg., Decatur, Clark, and Lee Counties.

Encoptolophus sordidus sordidus Burm., Clark, Warren, Decatur, Adams, and Lyon Counties.

Hippiscus rugosus Scudd., Van Buren, Clark, Sioux, Warren, Harrison, Lyon, and Plymouth Counties.

Hippiscus haldemani Scudd., Harrison, Sioux, Plymouth, Union, and Audubon Counties.

Dissosteira carolina L., common in Pottawattamie, Warren, Davis, Webster, Monona, Audubon, Clark, Clay, Sioux, Woodbury, Plymouth, and Harrison Counties.

Spharagemon bolli Scudd., Lee County.
Spharagemon equale Say, Lyon County.
Spharagemon collare Scudd., Muscatine, Sioux, Clark, Clay, and Harrison Counties.
Mestobregma kiowa kiowa Thos., common on prairies in Plymouth, Sioux, Lyon, Harrison, Monona, and Woodbury Counties.
Mestobregma kiowa fuscifrons Stal, Warren and Clark Counties.
Psinidia fenestralis fenestralis Serv., Muscatine County on sand hills.
Trimerotropis citrina (atypic) Scudd., Muscatine County on sand hills.
Trimerotropis laticincta Sauss., Story County, new State record, Hebard.
Hadrotettix trifasciatus Say, Lyon, Sioux, and Plymouth Counties.
Schistocerca americana americana Drury, Clark County.
Schistocerca alutacea lineata Scudd., more abundant than usual in Clark, Woodbury, Plymouth, Union, and Warren Counties.
Schistocerca alutacea alutacea ? Harr., Warren County.
Campylacantha olivacea olivacea Scudd., Clark County.
Melanoplus bivittatus Say, abundant, general in northwestern Iowa, Sioux and Crawford Counties.
Melanoplus differentialis Thos., generally abundant.
Melanoplus confusus Scudd., Plymouth and Sioux Counties.
Melanoplus femur-rubrum femur-rubrum Deg., generally abundant.
Melanoplus mexicanus mexicanus Sauss., generally abundant.
Melanoplus keeleri luridus Dodge, Warren, Plymouth, and Lyon Counties.
Melanoplus foedus fluviatilis Brun., Harrison, Lyon, Woodbury, and Sioux Counties.
Melanoplus angustipennis Dodge, Muscatine County.
Melanoplus gracilis Brun., Warren and Clark Counties.
Melanoplus scudderii scudderii Uhl., Union County.
Melanoplus walshii Scudd., Warren County.
Melanoplus borealis junius Dodge, Clay County.
Melanoplus packardii Scudd., Warren, Sioux, Clark, and Plymouth Counties.
Phoetaliotes nebrascensis Thos., Sioux and Lyon Counties.

MISSOURI

The most severe infestations were in the northwestern portion of the State. *Melanoplus mexicanus* was first in numbers with *M. differentialis* second, *M. femur-rubrum* third, and *M. bivittatus* fourth.

NEBRASKA

Except for the large sand hill area in the middle of the State, there were severe infestations all through the eastern, southern, and western parts. The important species were *Melanoplus mexicanus*, which was first in numbers, *M. differentialis* second, *M. bivittatus* third, *M. femur-rubrum* fourth, and *M. packardii* fifth.

NEVADA

The most severe infestations were in Lyon County and in the northern and northwestern parts of the State. Cannula pellucida was the only species recorded as important.

NEW MEXICO

The area where the most trouble is expected is in northern Santa Fe County and in Rio Arriba County. Over the entire State populations were down. Melanoplus bivittatus and M. femur-rubrum were the most important species.

OKLAHOMA

The worst infestations were in the northeastern and southwestern quarters of the State and over all but the southeastern quarter conditions were from light to threatening. Severe drought and heat delayed egg laying until the middle of September and also destroyed large numbers of adults.

The dominant species was Melanoplus differentialis, with both M. mexicanus and M. bivittatus second in importance.

OREGON

Grasshopper populations were lower than normal in most areas surveyed. All threatening infestations were found on range lands. The south-central and extreme northeastern parts of the State had the worst infestations.

Cannula pellucida was by far the most important species, but there were extremely localized infestations of Melanoplus mexicanus and M. femur-rubrum.

KANSAS

Infestations were general over the entire State. The most important species were Melanoplus mexicanus, M. differentialis, and M. bivittatus, in the order of their importance.

SUMMARY

The most important change that took place in the relative abundance of the species was the increase of Melanoplus femur-rubrum in several of the States where collections were made, viz., Wisconsin, Minnesota, and Utah. In eastern Iowa it was the most numerous species and in southern Minnesota it was the most destructive of the grasshoppers. Another change was the increase of Aulocara elliotti in the Mountain States, both on the range and in small grain. In Montana Cordillacris crenulata dropped from first to eighth place in abundance

in the grazing areas. M. mexicanus increased its lead over its closest competitors as much as 36 percent in small grain in western North Dakota, where it reached its greatest importance in relation to the other species. In both North Dakota and Montana it constituted 60 percent of the grasshopper population in idle or reverted lands. This bears out the fact that such places are good habitats for this particular species. Amphitornus coloradus, Phlibostroma quadrimaculatum, and a few others had fallen off in numbers.

In areas where drought was severe in 1936, drastic reductions in adult populations occurred last summer. Melanoplus bivittatus and M. differentialis, especially, suffered great mortality from the extreme heat and drought. These species were prominent only in the irrigated sections of some of the Mountain States and along the water courses in some other States.

Man has disturbed the balance of nature in the original flora of all these areas by farming and grazing practices and by introducing new plants. These new food plants, largely crops, are in turn more susceptible to weather changes than are the fully adapted native plants. This change in flora has had its effect on the original grasshopper fauna by causing rapid fluctuations in the relative numbers of any species. This, in part, accounts for recent outbreaks. Of all the species involved therein, M. mexicanus seems to have been able to retain its supremacy under the last 4 years of severe drought conditions, which indicates that this species was best adapted to such conditions.